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ABSTRACT

Digital literacy involves more then just using software. It includes reading instructions from graphical interfaces (photo-visual literacy), utilizing digital reproduction in learning (reproduction literacy), constructing knowledge from non-linear navigation (lateral literacy), and evaluating information (information literacy). These literacies serve as a measure of learners' work quality in digital environments. This paper proposes a terminology framework for digital literacy. Discussion of every literacy type is accompanied by results from a study that examined the ability of learners to effectively utilize digital literacy in educational contexts. (Contains 16 references.) (Author)

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Digital literacy: A new terminology framework and its application to the design of meaningful technology-based learning environments

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Abstract: Digital literacy is more then just using software. It includes reading instructions from graphical interfaces (photo-visual literacy), utilizing digital reproduction in learning (reproduction literacy), constructing knowledge from non-linear navigation (lateral literacy), and evaluating information (information literacy). These literacies serve as a measure of the learners' work quality in digital environments. The present paper proposes a terminology framework for digital literacy. Discussion of every literacy type is accompanied by results from a study that examined the ability of learners to effectively utilize digital literacy in educational contexts.

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Introduction

The fast developments in digital technologies during the last decades confront members of the technological society with situations that require the utilization of an ever growing assortment of cognitive skills, termed 'digital skills'. Examples that are commonly given to these skills include the ability to access or retrieve data, to use computer programs, and to operate digital appliances. Using digital skills require the users to own a relatively new kind of literacy, termed **'digital literacy'** (Lanham, 1995; Pool, 1997; Inoue, Naito and Koshizuka, 1997). However, digital literacy is much more then just the physical proficiency in operating computer programs, as many studies describe. It is a special kind of mindset, a special kind of thinking. For example: using a computer program involves the user's ability to communicate by deciphering, or 'reading' messages embedded in its interface. It also involves retrieving data from the Web, which requires the user's knowledge, not only of how to use search engines, but mainly of how to evaluate the retrieved data and distinguish between its relevance and non-relevance. It also requires a smart use of the hypermedia technology that involves lateral-associative thinking, which is very different from the traditional, linear reading of a book. The digital reproduction (copy and paste) capability of computers face learners with new horizons and offers a new meaning to creativity and ingenuity. All the above require the utilization of a new, very elaborate and flexible way of thinking, that is typical of digitally literate learners.

This paper proposes a terminology framework, and describes the major dimensions of digital literacy. It presents some research findings on the utilization of these types of literacy among youth and adult learners.

Methodology

In order to investigate the various aspects of digital literacy, three groups of participants were selected. The three groups were:

- 10 high-school students (age 14-15)
- 10 college students (age 24-28)
- 10 adults (age 30-40)

All participants were given assignments that required performing the ability to use different kinds of digital literacy: each assignment designed to address a different literacy. Details on each assignment are given below. The participants worked on the assignments individually. Each age-group worked separately, but at the same time. The assignments required the participants to perform work with computer programs. The participants were observed as they worked on the assignments, and notes were taken regarding the nature of their work while performing the tasks. The outcomes of the assignments, as well as the documentation of the processes of each participant's work, were used to assess and comment on their digital literacy. At the moment, the research findings are not yet completely analyzed, and, therefore, only the clearest and most prominent results are presented. For the sake of coherence, in the paper, every dimension of digital literacy is presented separately, and

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then discussed with respect to the relevant research findings, that are used to elaborate on its educational significance and utilization.

Photo-Visual literacy - Learning to read from pictures

Writing is a means of communication using symbols. It has evolved through history from a pictorial alphabet, that used meaningful symbols to represent words or letters, and therefore required a low level of cognitive mediation, to an abstract alphabet that uses "meaningless" symbols (letters) and therefore requires a higher level of cognitive mediation. The evolution of computer interfaces show a reciprocal trend, evolving from non-interactive, text-based, hard-to learn batch interfaces, into intuitive picture-based, easy-to learn Graphic User Interfaces (Nielsen, 1993). The first interfaces (either in CP/M or in DOS operating systems) were operated by text-based commands and required a very high cognitive mediation on the user's side (e.g. memorizing commands and understanding commands' syntax). In the 90's, under Windows environments, interfaces evolved into the icon graphic-based, highly-interactive Graphic User Interfaces, that are highly-intuitive and easy to learn. They appeal to the user's intuition and do not require a high cognitive mediation (Shneiderman, 1998). The evolution of interfaces marks three major trends: (1) an increase in the level of visualisation, (2) an increase in the level of interactivity, and (3) a decrease in the level of cognitive mediation required to reach proficiency in the use of the interface. Since computer interfaces communicate between the user and the program as they contain the information necessary to operate the program, using an interface should be regarded as a reading skill (Mullet and Sano, 1995). Therefore, the evolution of interfaces can be regarded as an evolution of a new kind of writing, from abstract text-based to concrete icon-based communication. We suggest that in order to perform well with this new means of communication, one must have a good command of a unique form of digital literacy – the **'photo-visual literacy'** - that the graphic interfaces have brought about: a literacy that requires the ability to use visuals (icons) as messages or "text", as described by Snyder (1999).

In order to examine how different users cope with different types of interfaces, we ran a usability test of two programs that share the same major objective (to design a stage), but are designed under a completely different approach: One (*Stage Struck*) has a pure graphical interface: almost no menus and no 'formal', pre-defined target. It is the user's responsibility to find out how and what should be done in the program. The other program (*The Opening Night*) has a very structured and quite 'expected' design (though it is also graphic). It is menu-driven; menus are textual; the user's task is well explained and determined in a text form.

The present research results show that the Adults group performed better with the more traditional interface of *Openning Night*, whereas the youngest participants performed better with the highly intuitive and graphic interface of *Stage Struck*. In addition, the research participants included three dyslexic persons, who were not fluent readers of a regular text. It was interesting to find that they scored among the highest with the graphic interface of *Stage Struck*, but were very unsuccessful with the traditional, more text -based interface of *The Openning Night*.

Our research has pointed to another aspect of photo-visual literacy that involves the way young children learn how to read a new language. During interviews with the research participants, we came across, and documented two cases of 4-5 year old children (Chilian and Israeli) who learned to read and speak some basics of a foreign language (English) from 'living books' types of programs such as *Just Grandma and Me* (http://www.thereviewzone.com/grandmame.html). In these programs, the text is highlighted phrase by phrase, simultaneously with the narration. From discussions with the children, and then with their parents, we discovered that these children were able to pick up the words, and to formulate preliminary spoken sentences that are beyond the sentences read to them in the program. In doing so, they were tracking the highlighted words , and combined the visual shape of each word with its narration. This case seems to suggest another kind of digital literacy, that enables learning new languages through perceiving words as 'pictures', rather then a combination of letters, and by synthesizing audiovisual stimuli (Beavis, 1999).

Reproduction literacy: The copy and paste culture - a new interpretation of creativity and ingenuity

The invention of the press by Gutenberg (1455) marked the first big leap in the ability of humans to copy, reproduce and distribute information in a large scale. The second big leap was made possible by the digital reproduction capabilities (e.g. the Copy and Paste feature) of computers, that enabled people to reproduce or edit digital texts or visuals, (Benjamin, 1994). The unlimited possibilities to reproduce and distribute digital information led to new interpretations of originality, creativity and ingenuity of artwork as well as of academic text. These interpretations ask questions such as "How far can one copy or edit artwork or text, so that it is still considered an original work and not plagiarism?" "What are the limits of creativity? When does it become a technical act of reproduction?" A classical case that pushed the limits of meaning ful art in the reproduction era was the case of Drako Maver (1998) (http://www.kapelica.org/maver/main.htm). Maver was a non-existent person who was invented as an Internet artist, and whose works were a collage of pictures of corpses copied from the Web and edited. This faked artist was invented and introduced by a group of Italian students as part of a large-scale effort to challenge the limits of art in the reproduction era. So successful was this effort that Maver even won some prestigous awards for his pioneering Internet art works... (of course, the referees were not aware of his non existent nature). Can these works be considered art, real, original, and creative? Coping with this challenge requires a special kind of digital literacy on the side of the digitally-literate user. We tentatively term this literacy '**Reproduction Literacy**'.

In the present study, we investigated people's attitute towards reproduction literacy in two ways: (1) by presenting them with the the Maver case and asking whether they would consider it art work and (2) by giving them a digital essay, asking them to edit it (rearrange words; add/delete text), so that it can be used in a completely different context Results clearly show the attitude differences between younger and older people The recognition of Maver's work as a legitimate authentic artwork decreased from 75% among the youngest group (high-school students) to 39% among the college students, and to only 13% by the adult group. The opposite was found for the second task, that required participants to reuse text in order to create something original. Here, the adult group performed the best (43% of them succeeded in fulfilling the task). Success dropped to 35% with the college students, and to only 19% with the high-school students. This finding, of decreasing success from older to younger learners, conforms with reports of Labbo, Reinking and McKenna (1998), that described problems of treating digital text by young students compared with that of adults.

Lateral literacy: Hypermedia and thinking

Besides improving people's performance with computer programs, the hypermedia technology introduced computer users with new dimensions of thinking and new challenges of digital literacy, that are necessary in order to make an educated use of this elaborate technology. In the past, the limited non-hypermedia-based computer environments enhanced a more linear thinking that was dictated by the the non-flexible operating systems, and the fact that users were used to books, and expected to work with computer-based environments in the same way thay read through books. From an educational perspective, the major importance of the hypermedia-based environments is not so much the multi-tasking work they allow the user, but the ability to use these environments for navigating laterally, in a non-linear way, through knowledge domains. This capability enhances a lateral, multi-dimentional thinking, and has led to the evolution of a new kind of digital literacy – '**lateral literacy**'. Rouet and Levonen (1996) discussed the impact of the hypermedia technology on learning. They suggested that this technology helps learners to move away from linear thinking into a rich-associative lateral thinking. According to them, in order to perform demanding multi-level tasks, learners must be able to think laterally and synthesize knowledge from pieces of information that are collected in different, sometimes independent, domains of knowledge. Spiro, Feltovitch, Jacobson, and Coulson. (1991) discussed the role of hypermedia in forming a multi-dimentional knowledge, based on flexible cognition. Some authors (e.g. Salomon, 1996) raised doubts as to the ability of learners to form meanungful knowledge by surfing in hypermedia environments as the Internet.

In order to examine the level of lateral literacy among learners, the participants of our research were asked to perform a similar task: To plan a trip in a foreign country by using information from the Internet. This task requires the learners to utilize lateral literacy in order to combine independent pieces of information (collected by laterally surfing in the Internet), in order to construct knowledge (the trip). Although analysis of results is not yet completed, findingss seem to point to the high ability of the youngest participants (high-school students) to perform the task. The weakest performers were the adults, who tended to stick to linear surfing, that is, they made very limited use of the hypermedia technology, which led to a very poor outcome (a plan of a trip

to a foreign country). These findings probably reflect the extensive exposure of young people to hypermedia environments. It may suggest that the exposure of learners to rigid, linear learning methods harm their cognitive flexibility, and affect their ability to cope with ill-structured problems (Spiro et al., 1991). On the other hand, the research findings may indicate that the extensive exposure of young students to the lateral, non-linear surfing on the Web, improved their ability to utilize multi-level constructivistic cognitive skills.

Information literacy: Trust nobody

Today, with the exponential growth of available information, the consumers' ability to evaluate and assess information has become a key issue in training people to become educated consumers of information (Kerka, 1999; Salomon, 2000). Information can be be classified into the following general groups: (1) primary objective information (e.g., all kinds of census data, migration routes of birds, distribution of volcanoes, satellite images, and weather information). It is usually easy to assess the validity of this information; it is original and relatively unbiased. (2) primary subjective information (e.g., much of the news in newspapers and diaries). These are usually biased to some extent, and it is usually hard to assess the quality and validity of this type of information because the average consumer is not fully aware of the fact that the term 'truth' is very subjective, and that even 'objective' information (what people call 'fact') can be easily treated in a biased way to produce a very subjective piece of information. (3) synthetical information (e.g. journalist articles, scientific hypotheses and models). This type of information is usually professional, more mature in its nature, and usually attracts relatively educated, sometimes professional, consumers, who are capable of assessing the quality of information properly.

We suggest that the ability of information consumers to make educated, smart, information assessments requires a special kind of literacy, termed here '**Information Literacy**'. This literacy acts as a filter: it identifies false, irrelevant, or biased information, and avoids its penetration into the learner's cognition (Minkel, 2000). It is true that information literacy is not unique to the digital age only. It was always a crucial trait of successful scholars, even before the information revolution of the digital age. But in the digital age, with the unlimited exposure of humans to digital information, this has become a crucial prerequisite that enables learners to make an educated use of digital information. Without a good command of information literacy, how can one decide which, of the endless pieces of contradicting information found on the Web, to believe? Which of the news on the Web to trust? Which political opinion posted on the Web to adopt?

In the present research we examined information literacy. All participants were asked to access seven different Internet sites that contain Middle East news (the Internet site of a main-stream Israeli newspaper; a terrorist organization information Internet site; a site of an Israeli government news agency; two private, politically-oriented news sites; an Arab country news site, and a site of a European news agency). Participants were given several events (news) that were reported in all of the examined sites. They were asked to assess and rate the quality and objectivity of the news. Analysis of results is yet incomplete, but one trend is evident: The younger the participants, the lower their information literacy. In other words, the oldest participants showed a significantly higher ability (49%) to apply critical thinking to information, compared to the youngest participants (15%). These findings, especially in the light of the fact that youngsters are among the most extensive consumers of digital information (in the Internet or in other forms of digital information and communication), illustrate the critical importance of emphasizing the inclusion of teaching information literacy in education systems. The low 49% for adults is also very worrying. It doubly suggests that information literacy be taught in schools.

Conclusions

This paper presents various aspects of digital literacy that are usually neglected in educational research concerning the impact of digital information on our society in general, and our education systems in particular. It proposes a terminology framework for digital literacy, i.e. photo-visual literacy, lateral literacy, reproduction literacy, and information literacy. The following (preliminary) research results were found for each type of literacy:

- The youngest participants (14-15 years old) were the best utilizers of photo-visual literacy; they were capable of working very well with graphic interfaces while the older participants were better with more traditional, menu-driven, or text-based interfaces.
- The dyslexic participants performed better with graphic interfaces, then with traditional, more text-based ones.
- The older participants were the most reproduction-literate learners; they were best in rearranging or re-using prior information into new forms of knowledge. On the other hand,

the youngest (14-15 years old) participants were more flexible in their perception of the originality and ingenuity of works made using digital reproduction methods (albiet a sophisticated 'copy and paste').

- The youngest participants (high-school students) showed the highest level of lateral literacy, which seemed to decrease with the older age groups. This finding is probably strongly related to the extensive exposure of youngsters to the hypermedia environments of the Internet.
- The oldest participants in the research (>30 years old) had the highest level of information literacy, whereas the younger participants were not overly capable of making good evaluations and assessments of information. This finding illustrates the importance of emphasizing teaching critical information literacy in educational systems, especially in schools.

In general, two, different, modes of approaching digital literacy were evident among the research participants: The **technological mode** (using modern graphic interfaces; surfing the Web in non-linear ways), and the **pedagogical mode** (creating meaningful digital reproductions of knowledge; critically evaluating information). The younger participants were better performing technological tasks whereas the older participants performed better in pedagogical tasks.

More research and data analysis are required in order to examine the validity and aplicability of our findings in wider populations.

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